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ABSTRACT

The influence of learning styles on achievement in hypertext was investigated. The learning styles of 21 female and 20 male subjects enrolled in an Introduction to Psychology class was assessed using the Learning Style Inventory (LSI) (D. Kolb, 1985). The LSI categorizes respondents into one of four learning styles based on their abilities in the four stages of the experiential learning cycle. Subjects were presented with a hypertext module from a Web-based Introduction to Psychology course and a printed version of the same module. Achievement was assessed with 4 20-question multiple choice quizzes, each composed of 10 factual and 10 conceptual questions. Two quizzes were presented for each condition; one set was presented immediately, and an alternate set was presented 7 days later. It was hypothesized that Assimilators and Convergers would score highest on all measures of achievement. However, a significant difference was found between Divergers, who scored highest, and Accommodators, who scored lowest. The results support previous research, which indicated that the benefits of hypertext are differentially distributed across learning styles. (Contains 1 table and 23 references.) (SLD)

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Running head: Hypertext and learning styles

The Influence of Learning Style on Achievement in Hypertext

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Abstract

The influence of learning styles on achievement in hypertext was investigated. The learning style of 21 female and 20 male subjects enrolled in an Introduction to Psychology class was assessed using the Learning Style Inventory (Kolb, 1985). The LSI categorizes respondents into one of four learning styles based on their abilities in the four stages of the experiential learning cycle. Subjects were presented with a hypertext module from a web-based Introduction to Psychology course and a printed version of the same module. Achievement was assessed with four, 20 question multiple choice quizzes each composed of ten factual and ten conceptual questions. Two quizzes were presented for each condition; one set was presented immediately, and an alternate set was presented seven days later. It was hypothesized that Assimilators and Convergers would score highest on all measures of achievement. However, a significant difference was found between Divergers, who scored highest, and Accomodators who scored lowest. The results support previous research, which indicate that the benefits of hypertext are differentially distributed across learning styles.

The Influence of Learning Style on Achievement in Hypertext

Post-secondary education has witnessed an exponential proliferation of web-based courses over the past years, a trend that is certain to continue. Researchers have identified several elements of this educational technology that have the potential to influence learning outcomes, one of which is hypertext. However, experimental results have not consistently shown significant or powerful main effects for this variable (Dillon & Gabbard, 1998; McKight, Dillon, & Richardson, 1991, 1996; Chen & Rada, 1996). This has prompted researchers to examine the interaction of hypertext and other variables. Learning style appears to be a promising candidate. Dillon & Gabbard (1998) conducted a meta-analysis of the current research on hypermedia and concluded that "...the benefits of hypermedia in education ... are differentially distributed across learners depending on their ability and their preferred learning style" (p. 322). The purpose of this study is to explore the relationship between hypertext and learning style further in an experimental, quantitative manner.

Hypertext

The term "hypertext" was first used in the late 1960's by Theodore Nelson (1981) who needed a new term to describe a distinctly new method of presenting information to readers. Jonassen (1991) expanded on Nelson's seminal work and constructed the following definition: "Hypertext refers to the nonsequential, nonlinear method for organizing and displaying text that was designed to enable readers to access information from a text in ways that are most meaningful to them" (p. 188).

Of the four types of hypertext described by Jonassen (1986), this study employed the "basic" type. It is characterized by hyperlinked text, menus, and navigational icons, which provide access from one part of the text to related sections in other parts of the document. Our presentation was also hierarchical. Melara (1996) uses the term "hierarchical" rather than "networked" when information is structured by the author "...using a bottom-up approach; allowing the learner to access subordinate concepts, bit by bit, until all the instruction is completed" (p. 315).

Many of the proposed benefits of hypertext are based on its ability to support individual differences. Jonassen (1986) argued that hypertext allows readers with different interests, learning styles, and information needs to determine their own sequence of interaction with a text. Lee (1992) suggested that a hypertext presentation can be structured to simultaneously support learners who need a structured and linear progression, and learners with less structured learning style who synthesize information while jumping from one path to another. Melara (1996) suggested that hypertext can support active learners who to like to browse through material after they complete a reading, and reflective learners who prefer to ponder what they have read. This early theoretical analysis suggests a possible improvement in learning outcomes for all students in a hypertext environment.

However, experimental research has not yielded consistent, significant main effects for hypertext presentations when compared with non-hypertext presentations or different variations of hypertext presentations. In their meta-analysis, Dillon & Gabbard (1998) reviewed 100 quantitative studies conducted from 1990-1997. Their research focused on three areas. First, they looked for main effects for comprehension in hypermedia and non-hypermedia presentations. In their summary of this research, Dillon & Gabbard refer to the results as "...at best, inconclusive" (p. 334). They also looked at the influence of increased learner control. Summarizing the research in this area, the authors comment that "...the ability to control pace and delivery of information, even when coupled with selection advice, appears insufficient to affect learning outcomes significantly .

. . " (p. 337). Thus, the question remains, which variables, if any, influence learning outcomes in hypertext environments?

The one variable that produced significant results in Dillon & Gabbard's (1998) meta-analysis was individual differences. The authors divide this construct into two areas, ability and learning style. A review of the learning style research follows. Jonassen & Wang (1993) examined the relationship between the Field Independent/Dependent model of learning style and levels of structure in hypertext. Their results indicated that field independent learners performed significantly better on recall tasks than their counterparts. This interaction became increasingly distinct as the level of structure decreased. Lee & Lehman (1993) focused on the model of learning style as measured by the Passive Active Learning Scale. They found that achievement increased significantly as subjects moved from passive, to neutral, to active learning styles. Beishuizen, Stuoutjesdijk, & van Putten (1994) grouped learners based on their strategies for interacting with new information. Learners who actively structured and related new information to existing information were called "deep processors"; learners who memorized and rehearsed new information were called "shallow processors". Consistent with previous research, the authors found no significant main effects for hypermedia. However, they exposed a significant interaction between structure and learning style which led them to conclude that hypermedia is best-suited for learners who actively impose their own structures on new information.

Learning Styles

The term "learning style" is a refinement and operationalization of the term "cognitive styles" for application to educational situations. Keefe (1979) constructed the following definition: "Learning style refers to the characteristic cognitive, affective, and psychological factors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Keefe, 1979, p.241). The acceptance of learning styles as an important construct in education lead to a number of individual studies and subsequent meta-analyses which found significant correlations between learning style and learning outcomes (Dunn, 1995; Sullivan, 1994; Bishop-Clark, 1992; Garlinger & Frank, 1986).

The Learning Style Inventory (LSI)

Dillon & Gabbard (1998) found sufficient evidence to suggest further research on the interaction of learning style and hypertext, but provided one caveat:

> The cognitive style distinction of field independence/dependence remains popular, but, as in most applications to new technology designs, it has failed to demonstrate much in the way of predictive or explanatory power and perhaps should be replaced with style dimensions that show greater potential for predicting behavior and performance. (p. 344).

One possible alternative is the Learning Style Inventory, Revised (Kolb, 1985), which has been used extensively in educational research. The Learning Style Inventory (LSI) is based on the experiential model of learning which views learning as a four-stage cyclical process in which learners encounter new information, reflect on that information, form hypotheses and theories, and test these theories.

In Kolb's nomenclature, these four stages are called, respectively: Concrete Experience--the ability to involve oneself fully and openly in new experiences; Reflective Observation--the ability to observe and reflect on new experiences from many perspectives; Abstract Conceptualization--the ability to create concepts that integrate observations into logically sound hypotheses and theories; and Active Experimentation--the ability to test hypotheses and use theories to solve problems and make decisions. Due to factors such as past experiences and present demands, individual learners develop and rely on some of these abilities more than others.

The next step for Kolb was to identify learning environments that supported these abilities. Students who rely on the Concrete Experience stage of learning cycle do well in "affectively complex learning environments" (Kolb, 1984, p. 198). In this environment, the information presented to students is concrete; activities simulate what students would do in the field; feedback is personalized; and information comes from discussions with peer and teachers. The Reflective Observation stage is supported by "perceptually complex environments" (Kolb, 1984; p. 198). The primary goal for students is to understand issues and identify relationships between concepts. To facilitate this, information is structured to allow students to view different perspectives and multiple opinions. "Behaviorally complex environments" (Kolb, 1984, p. 199) emphasize the Active Experimentation stage of the learning cycle. Here, the emphasis is on the practical application of skills to problem solving. Authentic tasks such as case studies and simulations allow the learner to feel intrinsic satisfaction after having solved problems. "Symbolically complex learning environments" appeal to Abstract Conceptualizers (Kolb, 1984, p.199). Information is authoritative, abstract, and is presented in the form of readings or lectures. During evaluation, learners are required to recall rules and concepts for which there is one right answer. This category comes closest to describing the hypertext presentation used in this study.

Since the introduction of the LSI in 1974, and its revision in 1985, several studies have used the instrument to explore the relationship between learning styles, learning environments and achievement. Reiff & Powell (1992) found that, in a class of 65 early childhood preservice students, the predominant modes of learning were Concrete Experience and Active Experimentation. Supportive of Kolb's theory, their results showed that role play and discussion were the most preferred instructional strategies, while lecture and independent study were the least preferred strategies. Ellsworth (1991) studied the effects of providing an optional bulletin board system (BBS) that adult students could use for information, communication, and mentoring. The realization that some students were using the BBS more than others led to the formulation of a research hypothesis. Results showed that students who focused on the concrete experience and active experimental stages of learning were more likely to use the BBS than others, and the purposes that they were using it for were interaction with peers and faculty, and reinforcement. Melara (1996) investigated the influence of structure and learning style in hypertext environments. His measurement of learning efficiency showed that Active Experimenters spent, on average, seventeen minutes longer on instruction in hierarchical hypertext than Reflectivists. The results of studies such as these indicate that the LSI may be an appropriate instrument for investigating the relationship between learning styles and achievement in hypertext.

According to Kolb's (1985) taxonomy, our hypertext presentation was classified as a symbolically and perceptually complex learning environment. The learning cycle phases associated with these environments are abstract conceptualization and reflective observation. The LSI group that combines these abilities is the Assimilators. Accomodators emphasize stages of the learning cycle that are contrary to those of the Assimilators, i.e., concrete experience and active experimentation. Thus, it was hypothesized that the achievement scores of Assimilators would be highest and achievement scores of Accomodators would be lowest.

Method

Subjects

41 subjects were selected from a face-to-face Introduction to Psychology class. Initially, a total of 88 subjects were administered the Learning Style Inventory (Kolb, 1985), but only ten subjects from each of the four learning styles were retained for the experiment. Selection from the initial group was based on two criteria: Subjects whose scores on the LSI optimally represented their particular category were selected preferentially; and preferences were made to ensure gender balance within the four categories. Each of the subjects that completed the experiment were given a two percent bonus on their final grade.

Materials

The Learning Style Inventory (Kolb, 1985) is a 12 item, self-report questionnaire designed to measure the degree to which individuals display the four learning style dimensions of concrete experience, reflective observation, abstract conceptualization and active experimentation. For each of the items, respondents are required to rank order four response phrases representing the four learning style dimensions in terms of how characteristic each dimension is of their learning style. Subjects received two separate modules (one on personality and the other on stress). The modules were taken from Laurentian University's web-based version of introductory psychology. Each subject received one of the modules in hypertext and the other in print. The print module was created by printing the frames of the internet course exactly as they would appear on the computer screen.

Subjects were given four multiple choice quizzes - two forms for each module. The questions for the quizzes were selected from four test banks: Test Bank to Accompany David G. Myers Psychology 4th Ed. (Bink, 1986), Study Guide to Accompany David G. Myers Psychology. (Straub, 1986), Study Guide for Plotnick's Introduction to Psychology 4th Ed. (Enos, 1996), and Study Guide: Understanding Psychology 2nd Ed. (Morris, 1993). Each quiz was composed of twenty questions: ten items addressed lower-level cognitive objectives; the other ten items addressed higher-level cognitive objectives.

Procedure

Students of the Introduction to Psychology class were administered the LSI en masse, and the tests were collected and scored by the experimenter. Selection of 40 subjects was then made according to the protocol described above. Subjects were tested in groups of ten. Testing conditions (ie. internet and print) and quiz forms were counterbalanced. Subjects were given brief instructions on how to navigate through the module and asked to begin. Once they had completed the module, they were given a 20-question multiple choice quiz on the material they had read. They were then provided with the other module and asked to complete a quiz once they had finished. Subjects reassembled seven days later to assess delayed recall. Subjects were asked to complete two new quizzes, one for each module.

Results

A two (presentation medium - hypertext/non-hypertext) by two (level of learning objectives - factual/conceptual) by two (time of testing - immediate/delay) by four way (learning style - Assimilator/Accomodator/Converger/Diverger) multivariate analysis of variance was performed. The analysis failed to show any significant main effects among the four learning styles on the dependent variables ($F(3,33) = 1.31$, $p > 0.05$). However, a significant interaction between learning styles and media was found ($F(3,33) = 2.72$, $p < 0.05$, eta squared = 0.21). A Tukey post hoc analyses showed that Accomodators' scores were significantly lower than Divergers' scores ($M = 7.15$, $s = 2.02$) See Table 1 for a complete list of means and standard deviations.

Table 1

Means and Standard Deviations for Learning Styles Groups

	Non-Hypertext		Hypertext	
Learning Style	M	S	M	S
Accomodator	6.18[a]	2.06	5.88[a]	1.62
Assimilator	7.00	1.80	6.41	1.70
Converger	7.10[b]	1.39	6.85	1.68
Diverger	6.43	7.15	7.15[b]	2.02

Note: (a) vs (b) significant at $p < 0.05$

Discussion

It was hypothesized that the achievement of Assimilators would be highest and the achievement of Accomodators would be lowest. The first part of this hypothesis was not supported. The Assimilators' scores were not significantly different from the scores of any other group. Their scores in the non-hypertext condition were lower than the scores of the Convergers, and their scores in the hypertext condition were lower than the scores of the Divergers. The second part of the hypothesis received limited support. The Accomodators' achievement was consistently lower than the achievement of all other groups, and in the hypertext condition, their achievement was significantly lower than the achievement of the Divergers'.

The Accomodators have an intuitive, active approach to perceiving and processing information. They perform best in environments in which concrete, practical information is presented through interaction with peers and instructors. They process information best when they can actively apply this information to authentic situations. Our hypertext presentation, like many found in web-based course delivery, emphasized perceiving and processing skills that are abstract and reflective. Not surprisingly, their achievement was lower than the achievement of other groups. We encountered some information early in the research that allowed us to anticipate this result: The initial base of potential subjects had to be continually enlarged until we were able to collect enough Accomodators for the experiment. Perhaps, Accomodators recognized long before we did that their strengths lie somewhere outside the university environment.

The authors' efforts to limit confounds and focus specifically on the interaction between learning style and hypertext many have resulted in an inauthentic experimental condition. Hypertext is rarely, if ever, employed as the sole media of delivery in courseware. The authors suggest that future researchers balance the control of confounds with ecological validity.

These results support earlier research that suggests that achievement in hypertext is differentially distributed across learning styles. However, the LSI was no more predictive or explanatory than the field independent/dependent construct questioned by Dillon & Gabbard (1998). We suggest that future attempts to link achievement in hypertext with learning styles explore different instruments.

Our hypertext module was selected from a web-course, and in this larger context, many instructional strategies, media, and activities are available to course designers. Computer-mediated communication (CMC), in particular, has the capacity to provide the kind of learning environments that could support Accomodators. CMC technologies such as email and conference boards can facilitate peer-peer and peer-instructor interaction through group work, personalized feedback, role modeling, and discussions. If hypertext alone does not fulfill the promise of serving all learners equally, a comprehensive web-based presentation may.

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